CLAIMS

1. A wide-gap semiconductor device, comprising:

a first pn junction formed by p-type and n-type semiconductor regions which operate as a bipolar semiconductor device, and forming a current path in the semiconductor regions;

an electric field relaxation layer provided within one of the semiconductor regions so as to be separated to an edge of the first pn junction, having a conduction type different from that of the one of the semiconductor regions, and forming a second pn junction with the one of the semiconductor regions surrounding thereof;

a first electrode electrically connected to the other of the semiconductor regions forming the first pn junction, opposed the one of the semiconductor regions between the first and second pn junctions with an electrical insulation film being intervening, and functioning as a current passage of the bipolar semiconductor device; and

a second electrode connected to the one of the semiconductor regions.

2. A wide-gap semiconductor device, comprising:

a first pn junction formed by p-type and n-type semiconductor regions which operate as a bipolar semiconductor device, and forming a current path in the semiconductor regions;

an electric field relaxation layer provided within one of the semiconductor regions so as to be separated to an edge of the first pn junction, having a conduction type different from that of the one of the semiconductor regions, and forming a second pn junction with the one of the semiconductor regions surrounding thereof;

a first electrode electrically connected to the other of the semiconductor regions forming the first pn junction, opposed the one of the semiconductor regions between the first pn and second junctions with an electrical insulation film being intervening, and functioning as a current passage of the bipolar semiconductor device; and

a second electrode connected to the one of the semiconductor regions,

wherein application of a voltage between the first electrode and the semiconductor regions so as to generate a depletion layer in the one of the semiconductor regions including the first pn junction causes that the first electrode imparts an electric field effect to the one of the semiconductor regions between the first and second pn junctions via the electrical insulation film, thereby the first and second pn junctions being electrically connected.

3. The wide-gap semiconductor device according to claim 1 or 2, wherein one semiconductor layer and the other semiconductor layer forms a mesa structure, the one semiconductor layer having a first conduction type which is

any one of the p-type and n-type, and the other semiconductor layer having a second conduction type which is the other of the p-type and n-type and forming the first pn junction with the one semiconductor layer,

wherein the electric field relaxation layer is formed in the one semiconductor layer having the first conduction type so as to be separated from the first pn junction, and has the second conduction type,

wherein the first electrode is opposed to the one semiconductor layer between the first pn junction and the electric field relaxation layer with the electric insulation layer intervening, and is connected to the other semiconductor layer of the mesa structure, and

wherein the second electrode is connected to the one semiconductor layer having the first conduction type.

4. The wide-gap semiconductor device according to claim 1 or 2, wherein one semiconductor layer and the other semiconductor layer forms a planar structure, the one semiconductor layer having a first conduction type which is any one of the p-type and n-type, and the other semiconductor layer having a second conduction type which is the other of the p-type and n-type and forming the first pn junction with the one semiconductor layer,

wherein the electric field relaxation layer is formed in the one semiconductor layer having the first conduction type so as to be separated from the first pn junction, and has the second conduction type,

wherein the first electrode is opposed to the one semiconductor layer between the first pn junction and the electric field relaxation layer with the electric insulation layer intervening, and is connected to the other semiconductor layer of the planar structure, and

wherein the second electrode is connected to the one semiconductor layer having the first conduction type.

5. A wide-gap semiconductor device, comprising:

a first pn junction formed by p-type and n-type semiconductor regions which operate as a bipolar semiconductor device, and forming a current path in the semiconductor regions;

an electric field relaxation layer provided within a second semiconductor region of the semiconductor regions forming the first pn junction so as to be separated to an edge of the first pn junction, having a conduction type different from that of the second semiconductor region, and forming a second pn junction with the second semiconductor region;

at least one third semiconductor region formed on a first semiconductor region of the semiconductor regions forming the first pn junction, and having a conduction type different from that of the first semiconductor region;

a first electrode electrically connected to the third semiconductor region,

and having an edge which is opposed to the second semiconductor region between the first and second pn junctions with an electrical insulation film being intervening;

a second electrode electrically connected to the first semiconductor region forming the first pn junction;

a fourth semiconductor region provided on one face of the second semiconductor region opposed to the other face of the second semiconductor region in which the first pn junction is provided, and having a conduction type different from that of the second conduction region; and

a third electrode provided on the fourth semiconductor region.

6. A wide-gap semiconductor device, comprising:

at least two first pn junctions, each of which is formed by p-type and n-type semiconductor regions operating as a bipolar semiconductor device and forms a current path in the semiconductor regions;

an electric field relaxation layer provided within a first semiconductor region of the semiconductor regions forming the first pn junction so as to be separated to an edge of the first pn junction, having a conduction type different from that of the first semiconductor region, and forming a second pn junction with the first semiconductor region;

at least one third semiconductor region formed in a second semiconductor region of the semiconductor regions forming the first pn junction, and having a conduction type different from that of the second semiconductor region;

a first electrode electrically connected to the third semiconductor region, and having an edge which is opposed to the semiconductor region between the first and second pn junctions with an electrical insulation film being intervening;

a second electrode electrically connected to a fourth semiconductor region which is the other of the semiconductor regions forming the first pn junction;

at least two third electrodes each of which is opposed to the semiconductor regions between the at least two first pn junctions with a insulation film being intervening; and

a fourth electrode connected to the fourth semiconductor region.

7. The wide-gap semiconductor device according to any one of claims 1 to 6 further comprising an ohmic contact layer provided between the fist electrode and the semiconductor region electrically connected to the first electrode,

wherein the insulation film is provided on a face of the semiconductor region so that a prescribed opening is kept between the insulation film and an edge of the ohmic contact layer.

8. The wide-gap semiconductor device according to claim 7, wherein the first electrode has a protruding portion formed so as to enter into the opening.

9. The wide-gap semiconductor device according to any one of claims 1 through 8, wherein the first electrode opposed to the semiconductor regions between the first and second pn junctions with the electrical insulation film being intervening is extended so as to overlap by a prescribed distance with the electric field relaxation layer forming the second pn junction with the electrical insulation film being intervening.

10. The wide-gap semiconductor device according to claim 7, wherein an insertion member made of a material which is hardly likely to react with a metal material of the ohmic contact layer is provided in the opening.

11. A power device, comprising a wide-gap semiconductor device as a control device,

wherein the wide-gap semiconductor device comprises:

at least two first pn junctions, each of which is formed by p-type and n-type semiconductor regions operating as a bipolar semiconductor device and forms a current path in the semiconductor regions;

an electric field relaxation layer provided within a first semiconductor region of the semiconductor regions forming the first pn junction so as to be separated to an edge of the first pn junction, having a conduction type different from that of the first semiconductor region, and forming a second pn junction with the first semiconductor region;

at least one third semiconductor region formed in a second semiconductor region of the semiconductor regions forming the first pn junction, and having a conduction type different from that of the second semiconductor region;

a first electrode electrically connected to the third semiconductor region, and having an edge which is opposed to the semiconductor region between the first and second pn junctions with an electrical insulation film being intervening;

a second electrode electrically connected to a fourth semiconductor region which is the other of the semiconductor regions forming the first pn junction;

at least two third electrodes each of which is opposed to the semiconductor regions between the at least two first pn junctions with a insulation film being intervening; and

a fourth electrode connected to the fourth semiconductor region.